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ABSTRACT

This paper presents a developmental study of the problem solving strategies of reflective and impulsive children. Subjects for the study were 30 nine-year-olds, 39 eleven-year-olds, and 23 thirteen-year-olds who had been classified as reflective or impulsive at ages 7, 9, and 11 and who had been followed longitudinally over a three year period. The Matching Familiar Figures (MFF) test and four problem solving tasks which provided information on problem solving strategies were administered each year during the program. The results of the study suggest that children who were classified as reflective on the MFF were more likely to adopt more systematic and/or mature strategies on tasks which required sequential hypothesis testing and information processing than were impulsive children of the same age. The longitudinal analysis suggested that reflective children acquired efficient strategies more rapidly over the early elementary years than did impulsive children. At the same time, the relative impact of reflection-impulsivity varied systematically with the developmental level of the subjects, with the relative difficulty of the problem for children at different stages of cognitive development, and with repeated experiences with the problems used in the study. (BD)

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Development of Problem Solving Strategies in Reflective and Impulsive Children

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Abstract

The subjects were 30 9-year-olds, 39 11-year-olds, and 23 13-year-olds who were classified as either reflective or impulsive at ages 7, 9, and 11, and were followed longitudinally for 3 years. Each year subjects were given the Matching Familiar Figures Test and four problem-solving tasks that provided measures of sequential information processing strategies. The relative impact of reflection/impulsivity on problem solving varied systematically with developmental level over the elementary age range, and the relative difficulty of the problem for children of different ages. During the early elementary period (ages 7-9) reflectives displayed a more accelerated rate of strategy development than impulsives on two of the four tasks. Differences in strategy development were not found between the ages of 9 and 11; however, in early adolescence reflectives showed greater gains in the use of optimal strategies than impulsives. Correlational analyses suggested that when reflectives performed more efficiently than impulsives, their tempo of responding could be attributed to more mature, systematic and necessarily time-consuming strategies.

Development of Problem Solving Strategies in Reflective and Impulsive Children

An extensive literature has evolved over the past decade which indicates that reflective children are more competent problem solvers and show better achievement than impulsive children (Kagan & Kogan, 1970; McKinney, 1975; Messer, 1976). At the same time, it is not clear from this literature exactly how individual differences in concept and tempo influence performance during problem solving or in the classroom environment. Recently, several major issues have been raised regarding the conceptualization, construct validity, and interpretation reflection/impulsivity, as defined by Kagan's (1975) Matching Familiar Figures Test (Block, Block, & Harrington, 1974; 1975; Haskins & McKinney, 1976; Salkind & Wright, 1977).

Kagan has proposed that performance differences between reflective and impulsive children are the result of anxiety over potential failure in situations of high response uncertainty (Kagan, Rosman, Day, Albert & Phillips, 1964; Kagan & Kogan, 1970). According to the anxiety hypothesis, impulsive children have developed an expectancy for failure and are motivated to remove themselves from the test situation as quickly as possible at the expense of accuracy. On the other hand, reflective children are overly concerned with making errors. However, since they are confident in their ability to deal with the problem, they adopt a very careful, time-consuming approach that insures accuracy at the expense of a quick evaluation. Unfortunately, impressive evidence has not been obtained to support a motivational explanation for performance differences when reflectives and impulsives have been compared on measures of test anxiety and other personality variables (Bentler & McClain, 1976; Block, et.al., 1974; Bush & Dweck, 1975; Messer, 1970). Similarly, several studies in which success and failure have

been manipulated during problem solving have not found differences between the two style groups (Messer, 1970; Reali & Hall, 1970).

Nevertheless, a number of investigators have attempted to modify impulsive responding in test situations in the hope that an alteration of response style would result in improved performance. In general, these studies have shown that response tempo can be increased by using modeling, enforced delay, or reinforcement techniques (Albert, 1970; Kagan, 1966; Kagan, Pearson & Welch, 1966; Reali & Hall, 1970; Yando & Kagan, 1968). However, these treatments have not been successful in reducing error rates in impulsive children. On the other hand, training procedures which have taught impulsive children more efficient information processing skills have been more successful in improving performance (Debus, 1970; Egeland, 1974; Meichenbaum & Goodman, 1971; Zelnicker, Jeffrey, Ault & Parsons, 1972).

The results of these studies suggest that greater attention should be devoted to the manner in which task information is processed by reflective and impulsive children rather than to the tempo of processing. If impulsive children have not acquired efficient strategies for processing task information necessary for solution, then training procedures which merely alter response tempo cannot be expected to improve the quality of their performance.

Recently, several studies have found that reflective children display more mature and efficient problem solving strategies than impulsive children in tasks that involved sequential information processing (Ault, 1973; Denney, 1973; McKinney, 1973, 1975). Also Zelniker and Jeffrey (1976) found that impulsive children tended to process information globally, whereas reflectives demonstrated a preference for analyzing stimulus detail. These studies suggest an alternative to the anxiety hypothesis for explaining performance differences between reflective and impulsive children in the absence of consistent

differences in IQ - that is, that they differ in the way they process task information to arrive at solution. The primary objective of the present study was to describe the longitudinal development of problem solving strategies in reflective and impulsive children during the elementary school period. While evidence has accumulated to suggest that reflective and impulsive children differ in the way they process task information, the course of strategy development in the two style groups is unknown. Similarly, little is known about the generality of strategy behavior with age and style groups. Therefore, it is important to determine whether individual differences in performance represent generalized approaches to a variety of problems, or whether they are unique to a given problem with particular stimulus or response properties.

Method

Study Sample

The total sample obtained during the first year of the project was composed of 109 7-year-olds, 83 9-year-olds, and 80 11-year-olds. All of the children were enrolled in a single elementary school and represented the total number of children available. Each child was tested with the Matching Familiar Figures (MFF) test in the fall of 1973 to select groups of reflective and impulsive children. Following the procedure recommended by Kagan (1966), subjects who scored above the group median for their age in response latency and below the median in errors were classified as reflective. The opposite criteria were used to classify subjects as impulsive. This procedure resulted in an initial longitudinal sample of 87 reflectives and 86 impulsives. Each child who was classified as either reflective or impulsive was given the Wechsler Intelligence Scale for Children (WISC), verbal scale. Subjects who scored more than one standard deviation below average were excluded from the sample.

A total of 43 subjects were lost the second year of the project, and an additional 38 were not available the third year. A total of 40 children in the youngest age group (Cohort A) were tested at 7, 8 and 9 years; 51 subjects in the middle age group (Cohort B) were tested at 9, 10, and 11 years; and 31 subjects in the oldest age group (Cohort C) were tested at 11, 12 and 13 years. Table 1 provides a summary of subject characteristics in the longitudinal sample for each year of the project. Inspection of these data indicated that the ages, IQs, and socioeconomic status of children in the reflective and impulsive groups remained comparable from year to year which suggests that subject attrition was not selective.

Insert Table 1 about here.

The final sample was composed of 39 boys and 53 girls. An analysis of variance on WISC verbal IQ scores indicated that reflective and impulsive children in each age group were comparable, although reflectives tended to score somewhat higher than impulsives at each age level. The sample contained 76 white children and 16 black children. The socioeconomic status of each child was classified as either upper, middle or lower by using the Hollingshead scale for parental occupation. A series of Chi-square analyses for each age group in the final sample failed to show significant differences in the SES distribution for reflectives and impulsives.

Experimental Design

The primary design was a 2 X 2 X 3 X 4 mixed factorial. The between-subjects factors were sex (male and female) and cognitive style (reflective and impulsive). The within-subjects factors were age within developmental levels (Cohort A, 7, 8 and 9 years; Cohort B, 9, 10 and 11 years; Cohort C, 11, 12 and 13 years) and order of problem administration for each task.

The order of problem administration for each task was varied by Latin squares, and each subject was randomly assigned to one of the possible orders.

Procedure

Subjects were tested individually in two separate sessions each year of the project. With the exception of the MFF, which required approximately 10 minutes, the sessions lasted from 30 to 45 minutes. In order to control for age variability in the longitudinal analysis, each subject was tested within 3 weeks of his original test date each year. The testing procedures and instructions were the same each year; however, specific problem solutions were changed to eliminate guessing.

Experimental Tasks

In addition to the Matching Familiar Figures test, each subject was given four tasks to assess his problem solving efficiency and strategy behavior.

Matrix solution. The stimuli for the matrix solution task were 16 drawings of flowers which varied according to size (large or small), color (red or blue), number of petals (four or six), and context element (yellow square or triangle in center). The stimuli were randomly arranged in a 4 X 4 matrix of 3-inch (7.62 cm) squares and were presented on a 12-inch (30.48 cm) square card. Subjects were given four problems in which they were instructed to find the correct flower in the array by asking questions that could be answered as yes or no. If the child asked a question that could not be answered as yes or no, the experimenter said, "Remember, I can't give you any answer but yes or no." A more detailed description of this procedure can be found in Eimas (1970) and McKinney (1973).

One convenient measure of the efficiency of information processing on this task is the expected or average amount of information obtained by each question. The expected information score for each response was computed as the sum of the informational outcomes in bits weighted by the probabilities of occurence. Since the mean information scores also reflect the number of errors made by the subject, it was considered desirable to provide a measure of the general approach or type of strategy followed by the subject as well as the efficiency with which the strategy was used. Each response or questions was scored as either an attribute, spatial, specific instance, or noninformative hypothesis. An attribute hypothesis was defined as a question about one of the four stimulus dimensions in the array, e.g., "Is it small?". A spatial hypothesis was defined as a question about the position of the correct element in the array, such as, "Is it in this row?". A specific instance hypothesis was scored when the subject selected a single stimulus. A noninformative hypothesis was scored when the subject asked a question that could not be answered as yes or now, or when he asked a question that provided redundant information.

Pattern matching. The stimuli for the pattern matching task were eight circular patterns composed of binary elements (black or white dots). Each pattern was drawn on a 4 X 6 inch (10.16 X 15.24 cm) card which contained four black dots and four white dots. The eight stimulus cards were displayed in a 2 X 4 array on a wooden board which was tilted at a 15^{o} angle. For each problem one of the eight patterns was concealed behind eight movable shutters in a 10-inch (25.4 cm) square problem board.

The procedure was similar to that used by Neimark and Lewis (1967). The child was told that his task was to identify the concealed pattern by uncovering as few of its elements as possible. In each problem, the stimuli were constructed such that on the first trial, four of the shutters would eliminate half of the patterns and four would eliminate single patterns. Each response which eliminated half of the remaining patterns on a given trial was classified as a focusing response and each response which eliminated a single pattern was classified as a scanning response. On succeeding trials subjects could make noninformative responses by opening shutters that provided redundant information.

Each of four problems used a different set of eight patterns and was introduced by saying, "Now find the pattern inside the board by opening as few windows (shutters) as possible." The expected information obtained by each response was computed in the same fashion as that for the matrix solution task. Additional dependent measures were the number of noninformative responses and proportion of focusing responses.

Twenty questions. Each subject was given a series of four problems which used a twenty-questions procedure similar to that developed by Mosher and Hornsby (1966). Two problems were administered under each of two conditions. In the first set of problems, subjects were shown the array of pictures used by Mosher and Hornsby (1966), and their task was to discover which picture the experimenter had in mind by asking questions that could be answered as yes or no. The second set of problems was presented verbally, and the subject was required to construct the alternative solutions as well as to determine the correct one.

The stimuli for the pictures problems were 42 colored drawings of common objects (e.g., shoe, bike, cow) which were arranged in a 7 X 6

array. Each subject was asked to locate two pictures in the array. The verbal problems differed from the twenty questions pictures problems in that the experimenter described an event for the subject and then asked the subject to find out how it had happened by asking questions. In the first problem the subject was talk that a boy (girl) left school in the middle of the morning and was asked to try to find out what happened by asking questions that could be answered as yes or no. The solution to the problem was that the child had been injured and had to go to the doctor or to the hospital. Subjects were allowed to ask a maximum of 20 questions, but also were allowed to give up after two, 30-second periods of silence.

Regardless of the subject's performance on the first problem, he was given a second one in which the experimenter said, "Now let's try one more. A man (woman) was driving down the road in his (her) car. The car went off the road and hit a tree. Why did the car go off the road?" The solution in the second problem was that it was snowing and the car skidded on the icy pavement. As with all other problem-solving tasks, the specific solutions for the verbal problems were changed each year of the project.

Subject's responses on each of the twenty questions problems were recorded verbatim. A question was classified as hypothesis-seeking (HS) when it referred to a single alternative (e.g., Pictures--"Is it the cow?", Verbal--"Did he fall asleep?"). Questions were scored as constraint-seeking (CS) when they eliminated two or more alternatives (e.g., Pictures--"Is it an animal?", Verbal--"Was he hurt?"). A

question was scored as noninformative if it could not be answered as yes or no, or if it providee redundant information.

Results

Problem-Solving Behavior

In order to compare the problem-solving efficiency of reflective and impulsive children, a 2(sex) X 2(cognitive style) X 3(age) multivariate analysis of variance was performed on selected dependent measures for each task. This analysis was performed separately for each age group in the longitudinal sample. The within-subjects analysis on longitudinal trends within age groups was carried out by computing the linear and quadratic contrasts for the repeated measures effects. The developmental trend for each variable and the resultant interactions with sex and cognitive style were tested by a multivariate analysis of variance on the two sets of contrast scores (McCall & Appelbaum, 1973).

Matrix solution. Figure 1 shows the average expected information scores in bits for reflective and impulsive subjects at each age level. The analysis of variance on the scores for each cohort failed to show significant main effects for either reflection/impulsivity or sex. Since the same finding was obtained for all other measures on this task, the means and standard deviations for other variables were not reported here.

Insert Figure 1 about here

The multivariate analysis of age effects for the information scores revealed a significant linear increase for all cohorts, and significant quadratic trends for Cohorts B and C. The general absence of interaction in the within-subjects analysis indicates that the pattern of strategy development on this task was the same for reflectives and impulsives and for boys and girls. Inspection of data in Figure 1 suggests that

the quadratic trend for Cohorts B and C can be attributed to ceiling effects between the ages of 10 and 13 years for this task.

Although the results for the oldest children in the longitudinal sample were not surprising given previous findings (McKinney, 1975), the failure to find performance differences between reflectives and impulsives in the youngest cohort is inconsistent with previous results (McKinney, 1973, 1975) on this task based on cross-sectional comparisons.

Pattern matching. Comparisons between reflectives and impulsives within the youngest cohort revealed significant differences in favor of reflectives on information scores, $F(1/26) = 3.67$, $p < .06$. Similarly, the repeated measures analysis indicated that reflectives showed a greater increase in information scores between the ages of 7 and 9 years than impulsives, $F(1/26) = 3.39$, $p < .07$. No significant sex effects or interactions were found in the between-groups analysis for Cohort A; however, the within-subjects analysis showed that girls made greater gains than boys, $F(1/26) = 5.22$, $p < .03$. These developmental trends are illustrated in Figure 2.

Insert Figure 2 about here

In general, no significant main effects or interactions were found for any of the pattern matching variables for Cohort B. Similarly, although significant linear trends were found for all variables (ps all < .001), no significant differences in the patterns of development were noted between reflectives and impulsives or between boys or girls.

On the other hand, highly significant effects were found within the oldest cohort, $F(1/19) = 15.39$, $p < .001$. Also, boys processed information less efficiently, $F(1/19) = 12.68$, $p < .002$, than did girls.

The within-subjects analysis for the oldest cohort yielded a significant quadratic trend, $F(1/19) = 8.59$, $p < .009$. Thus, the performance of both groups improved between the ages of 11 and 12 years and tended to stabilize at near ceiling between 12 and 13 years.

However, boys showed greater gains in information scores, $F(1/19) = 5.81$, $p < .02$, than girls, and impulsives showed a more rapid increase in efficiency than reflectives, $F(1/19) = 4.24$, $p < .05$. Therefore, although boys and impulsives displayed a greater deficit in performance at year 11, they made greater gains between the ages of 11 and 13 as the performance of girls and reflectives approached ceiling.

Twenty questions - pictures. The analysis of data in Figure 3 for Cohort A indicated that reflective subjects asked significantly fewer hypothesis-seeking questions than impulsive subjects, $F(1/26) = 4.09$, $p < .05$. Also the repeated measures analysis indicated that reflectives tended to show a greater linear decrease in hypothesis-seeking questions than impulsives between the ages of 7 and 9 years, $F(1/26) = 3.55$, $p < .07$. Although the overall effect for cognitive style did not approach significance, the longitudinal trend was for reflectives to show a greater linear increase in constraint-seeking than impulsives, $F(1/26) = 6.74$, $p < .01$. No significant sex effects or interactions were found for Cohort A.

Insert Figure 3 about here

The analysis for Cohort B yielded a highly significant sex X cognitive style interaction for the percentage of constraint-seeking questions, $F(1/35) = 5.43$, $p < .02$. Similarly, the sex X style interaction for hypothesis-seeking questions approached significance, $F(1/35) = 2.93$, $p < .09$.

Inspection of the cell means indicated that reflective girls displayed more advanced strategies than reflective boys, whereas impulsive boys were superior to impulsive girls.

The data from Cohort C on the twenty questions - pictures task indicated that reflectives asked reliably more constraint-seeking questions, $F(1/19) = 8.74$, $p < .008$, and fewer hypothesis-scanning questions, $F(1/19) = 4.60$, $p < .04$, than impulsives. Also, girls asked more constraint-seeking questions than boys, $F(1/19) = 7.91$, $p < .01$. Although the main effect for repeated measures was significant ($ps < .001$) in every case, neither cognitive style nor sex interacted with occasions of measurement, thereby suggesting that the pattern of development over this period was the same for both style groups and sexes.

Twenty questions - verbal. Inspection of the data in Figure 4 confirmed the initial impression from preliminary evidence that this was an exceedingly difficult task, even for the children in the oldest cohort. In fact, the between-subjects analysis for each cohort yielded only one significant effect. Reflectives in Cohort A asked more constraint-seeking questions than impulsives at the 8-year level, $F(1/26) = 4.05$, $p < .05$.

Insert Figure 4 about here

However, the analysis of developmental changes indicated an unusual pattern of quadratic trends within each cohort. With the exception of reflectives in Cohort B, subjects in each cohort tended to increase in constraint seeking and decrease in hypothesis seeking

between the first and second year measures, and to display the opposite trend between the second and third year measures. Given the difficulty of this task and the fact that the solutions were changed each year, this effect might be due to the relative probability of guessing the correct solution in a given year.

Response Tempo During Problem Solving

In order to determine the effects of cognitive style and age on response tempo for each task, the solution time for each subject was recorded in seconds on each problem and divided by the number of responses on that problem. In general, the between-subjects analysis of these data yielded significant effects for cognitive style. In Cohort A reflective children responded more slowly than impulsive children on the pattern matching task, $F(1/26) = 5.71$, $p < .02$. In Cohort B, reflectives were slower than impulsives on the twenty questions - pictures task, $F(1/26) = 4.89$, $p < .03$. No significant sex effects in response tempo were found.

Therefore, the data do not provide impressive evidence that reflectives and impulsives differed in response tempo on the problem-solving tasks that were used, nor is there strong evidence to suggest that they show different developmental trends in tempo of responding on these tasks. Similarly, with the exception of the twenty questions - pictures problems on which subjects showed a trend toward longer response times over the three periods of study, no consistent developmental pattern emerged that would suggest systematic changes in response style with age.

Table 2 shows the correlations between average solution times on each task and selected measures of strategy behavior on the same task each year of the study. These results generally support the conclusion that slow responding was positively associated with efficient strategy behavior. However, the magnitude of this relationship varied greatly across tasks and age levels within cohorts.

The positive relationship between response tempo and information processing efficiency was most evident for the pattern matching task. Highly significant correlations between information scores and response tempo were found for all three age elvels within each cohort with the exception of 13-year-olds in Cohort C. Positive correlations between tempo and constraint-seeking and/or negative correlations with hypothesis-seeking on twenty questions - pictures were found for ages 7 and 8 in Cohort A, ages 9, 10 and 11 in Cohort B, and age 12 in Cohort C. The same pattern of relationship was found for 8-year-olds in Cohort A, 10-year-olds in Cohort B, and 11, 12 and 13-year-olds in Cohort C on the twenty questions - verbal task.

Although slow responding was modestly correlated with attribute responses on matrix solution for 7-year-olds, the opposite relationship was found for 9-year-olds in Cohort A. Similarly, for 11-year-olds in Cohort B and Cohort C and for 13-year-olds in Cohort C, fast responding was associated with more efficient performance. In order to interpret this finding it should be noted that the matrix solution task was particularly easy for older children and was quite susceptible to practice effects. In fact, there was a progressive increase in the frequency of the optimal strategy from approximately 75% at year 9 to

95% at year 12. Thus, once competent problem solvers had acquired a focusing strategy for solving matrix problems and thoroughly practiced this strategy in repeated assessments, they were able to process information very rapidly in relation to less competent problem solvers.

These findings suggest that response tempo during problem solving is determined by the type of strategy that is used by a given child on that particular problem and the extent to which he/she can use the strategy effectively. Thus, when children proceed slowly and perform efficiently on a given task, their response tempo may be attributed to the use of more systematic and time-consuming strategies. However, once the optimal strategy has been fully acquired and well practiced it can be followed with greater speed without diminished accuracy.

Relationship Between Style Measures and Strategy Measures Over Age

In order to investigate the long-term versus short-term predictive value of the Matching Familiar Figures test, cross-age correlations were computed between MFF error scores and response latencies and the various measures of strategy behavior. This analysis used the entire longitudinal sample regardless of cognitive style classification and was carried out for the two MFF measures seaprately within each cohort.

MFF latency. In general, response latency on the MFF test proved to be a rather poor predictor of performance on all tasks and when significant correlations were obtained they were quite modest, ranging from .27 to .46. Only 1 of 18 correlations between MFF latency and information scores on matrix solutions was significant and only three were found between the same measures on pattern matching. Six out of 36 correlations for twenty questions - picutres were significant, and 4 out of 36 were significant for twenty questions - verbal.

MFF errors. Although MFF error scores were negatively correlated with information scores on matrix solution in 4 out of 18 cases, in only one instance was there prediction from one year to the next. By contrast, 12 of 18 correlations between MFF error and information scores on pattern matching were significant and cross-age correlations ranging from -.27 to -.42 were found for all three cohorts. A total of 14 out of 36 correlations were significant between error scores and strategy measures on twenty questions - pictures and 8 of these were found within Cohort C. On the other hand, only two correlations were significant for the twenty questions - verbal measures and both of these were obtained in Cohort C.

Thus, the relationships between error scores on the MFF and measures of strategy behavior were considerably stronger and more evident than those for response latency, and some evidence was obtained for prediction over a three-year period with two problem-solving tasks. These results suggest that individual differences in response accuracy as measured by the MFF test rather than response tempo account for the superior performance of reflectives when they are compared to impulsives on problem-solving tasks. Also, these results suggest that MFF error scores may be a more useful measure for identifying competent problem solvers than MFF latency or both MFF latency and errors, as is the usual practice.

Discussion

The results of the present study generally support the conclusion that reflective children as identified by the Matching Familiar Figures test were more likely to adopt more systematic and/or mature problem-solving strategies on tasks that require sequential hypothesis testing

and information processing than were impulsive children of the same age. Also, longitudinal analysis of problem-solving data over a three-year period supports the conclusion that reflective children displayed a more accelerated acquisition of efficient strategies over the early elementary years than did impulsive children. At the same time, the relative impact of reflection-impulsivity varied systematically with developmental level over the elementary age range, the relative difficulty of the problem for children at different stages of cognitive development, and repeated experience with the type of problem at hand.

Developmentally, the impact of cognitive style on problem solving was most evident in the behavior of children between the ages of 7 and 9 years on Pattern Matching and Twenty Questions - Pictures problems. Reflective and impulsive children who were followed between the ages of 9 and 11 years did not differ in problem-solving efficiency on any of the tasks that were used and both groups showed the same pattern of linear development over three years. Nevertheless, reflectives who were tested initially at 11 years in the oldest cohort were superior to impulsives on all measures of efficiency and strategy behavior for both the Pattern Matching and Twenty Questions - Pictures tasks. Following this initial discrepancy, the performance of both groups tended to stabilize at near ceiling levels between 12 and 13 years.

In general, the longitudinal results with respect to cognitive style differences in problem solving confirm those reported previously in cross-sectional studies (McKinney, 1973, 1975). However, the failure to find differences between reflectives and impulsives on Twenty Questions - Pictures at year 9 in Cohort B was not consistent with the data reported by Ault (1973). Also the negative findings for Cohort B were not consistent with Cameron's

(1976) data on the Pattern Matching task which replicated McKinney's (1975) results for 7 and 11-year-olds but not for 9-year-olds. In order to elucidate this apparent discrepancy in findings for children between 9 and 11 years of age, it is necessary to consider two factors--the effects of practice due to repeated measures in the longitudinal design, and the possibility of sampling bias in the original subject selection procedures.

In interpreting the developmental trends displayed by reflectives and impulsives it should be noted that the performance of the oldest children in each cohort was probably facilitated by prior experience with the task. An alternative explanation for differences between reflectives and impulsives at year 9 in Cohort A and at year 11 in Cohort C with no differences at years 9 and 11 in Cohort B may be sampling bias. However, the data that are presented on subject characteristics in Table 1 does not lend support to this interpretation. Although the results for Cohort B cannot be fully explained within the context of the present study, they do illustrate an important problem with the conventional methodology of cognitive-style research. Since reflective and impulsive children are selected based on sample-specific criteria, the potential for generalizing across different studies is often limited.

As expected from previous research (Kagan and Kogan, 1970; Messer, 1976), response latency and error scores on the Matching Familiar Figures test were moderately stable over a period of 2 years. In general, MFF error scores were less stable than MFF latencies. However, MFF errors were more highly correlated with measures of problem-solving efficiency than were MFF latencies. Therefore, the data suggest that response accuracy, as measured by the MFF test, rather than response tempo, accounted for performance differences between reflective and impulsive children.

These results tend to support those of Block, Block and Harrington (1974) and underscore their concerns regarding the interpretation and utility of the tempo dimensions. A key assumption in much of the research on cognitive tempo has been that MFF latency reflects a generalized predisposition to respond either slowly or quickly in situations of high response uncertainty. However, comparisons between reflectives and impulsives failed to show consistent or marked differences in tempo of responding on the four problem-solving tasks used in this study, nor was there evidence that they showed different developmental patterns with respect to tempo measures during problem solving.

Further, the analysis of the relationships between response tempo during problem solving and performance on the same task showed that the child's tempo of responding was a function of his/her strategy behavior. Thus, the data suggest that when reflective children performed more efficiently than impulsive children on a given task, their superior performance could be attributed to the use of more sophisticated strategies for processing task information, rather than their tempo of processing per se.

Therefore, one implication of these results is that modification of the impulsive style might be accomplished by either manipulating task variables during problem solving and/or by specific instruction in more efficient strategies. Since a number of studies have shown that young elementary school children can acquire and transfer rather complex problem-solving strategies (Anderson, 1965; Keislar & Stern, 1970; McKinney, 1972), there appears to be both practical and theoretical merit in focusing on the manner in which children process task information as opposed to their tempo of processing.

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